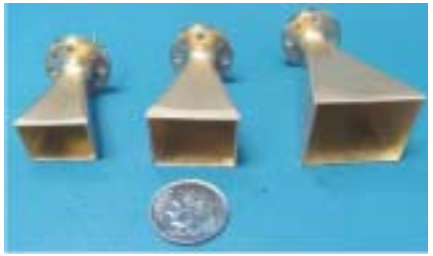


US Spectrum Policy & the 95 GHz Wall

Michael J. Marcus, Sc.D., F-IEEE

Director
Marcus Spectrum Solutions LLC
Cabin John, MD USA

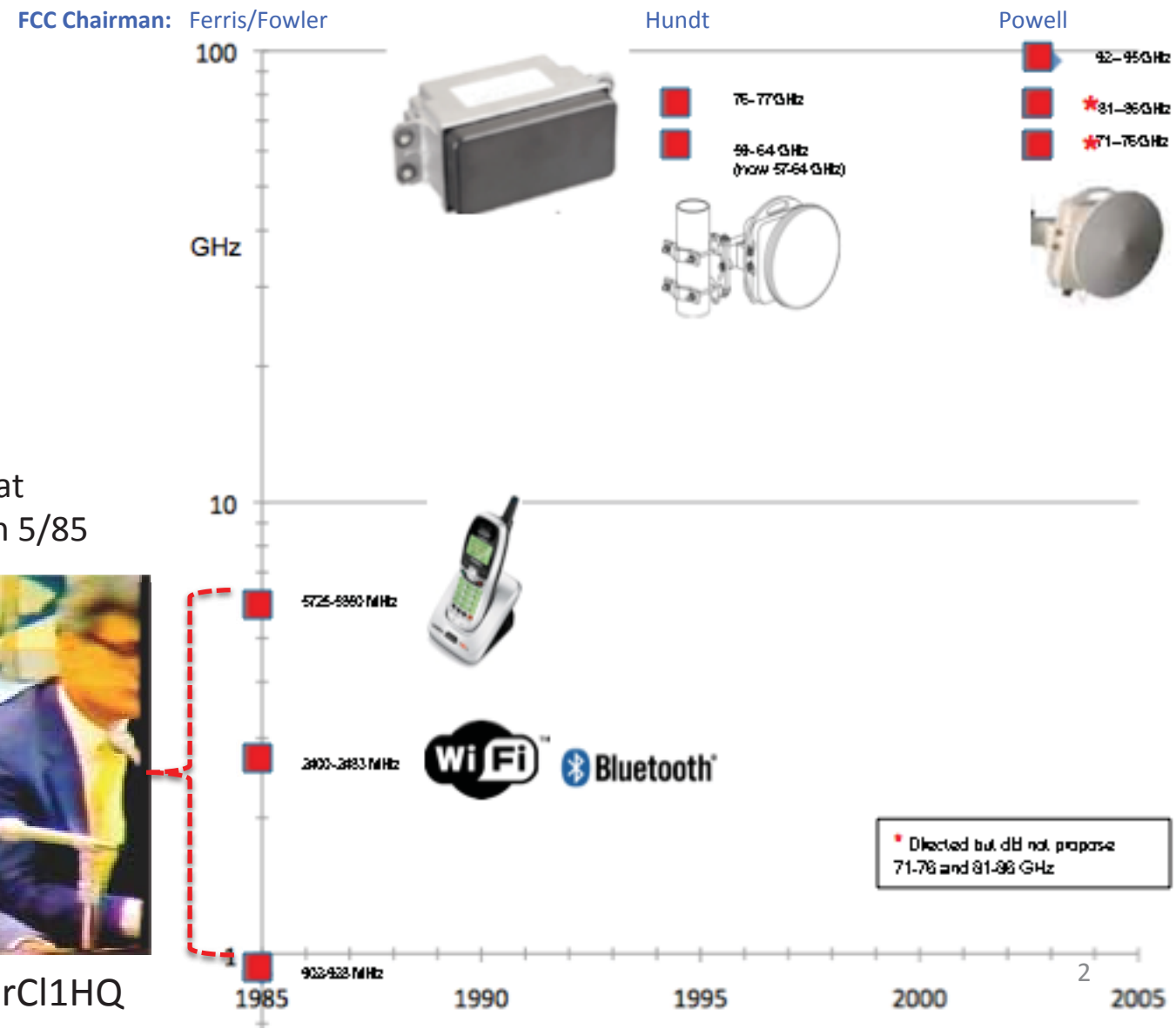
Adjunct Professor of ECE
Virginia Tech
Blacksburg, VA USA

Marcus Spectrum Solutions

mjmarcus@marcus-spectrum.com
www.marcus-spectrum.com

VirginiaTech
Invent the Future

My FCC career:



Creation of regulations that enabled Wi-Fi & Bluetooth 5/85

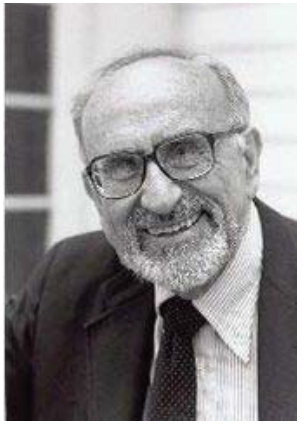
https://youtu.be/Z0xhFrCl1HQ

Basic Problem

- JR (2/9/16) "We have committed to seek comment on more millimeter wave bands in the future"
  - While this has been mentioned twice in passing in "Spectrum Frontier" NOI and NPRM - nothing has happened
  - Drafting error in Part 5 R&O discouraged R&D and took 2.5 years to correct *even though correction was uncontroversial*
  - RM-11713 and Docket 13-259 have been lingering for 2+ years
  - Role of §§7,303(g)?

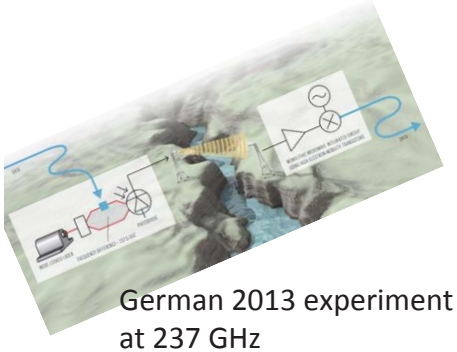
Charles Ferris
FCC Chair 1977-81

"Ferris/Kahn Doctrine"



Prof. Alfred Kahn
CAB Chair 1977-78

- To stimulate economic growth, find technologies prohibited by outdated regulations that would not cause harm and remove regulatory barriers
  - Origin of unlicensed ISM bands & Wi-Fi
- Closely related to "Hatfield Doctrine"
  - "If you are looking for interesting ideas in spectrum policy, takes things that people are doing illegally without causing harm and make them legal"



German 2013 experiment at 237 GHz

US vs. Others

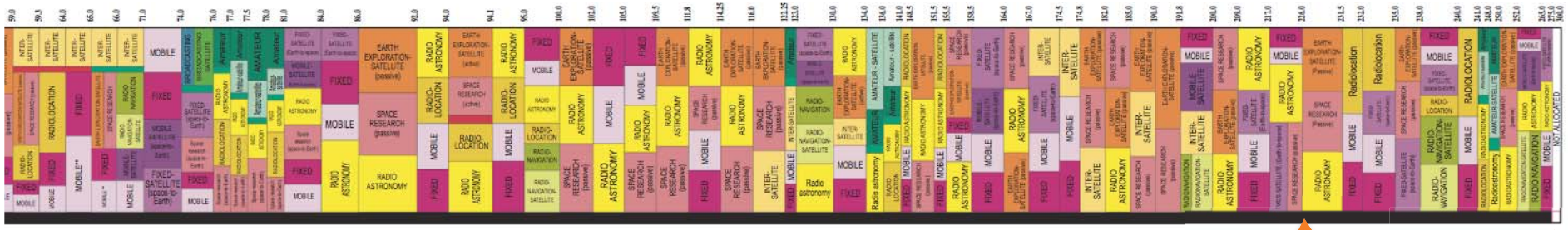
Japanese 125 GHz system used in 2008 Olympics

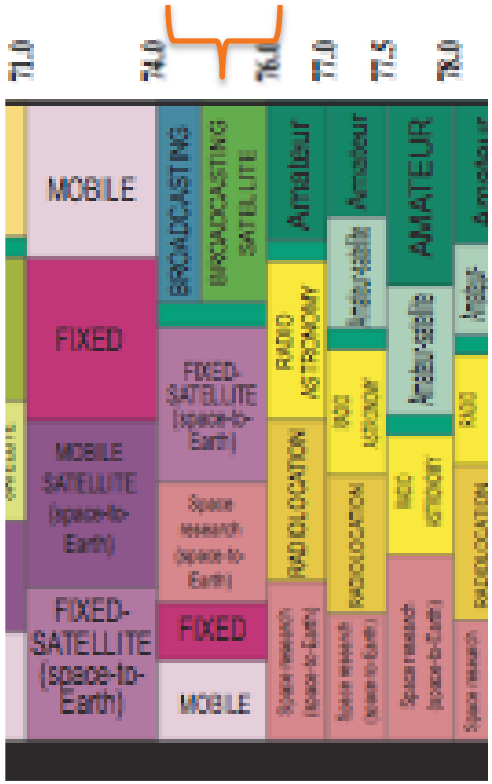
- While US (and ITU) allocations go up to 275 GHz, there are no licensed or unlicensed service rules above 95 GHz – a point reached in 2003
- EU and Asian countries are targeting 95+ GHz technology with industrial policies that include **both** R&D support and supportive spectrum management
  - "With respect to the aforementioned, the mission of ISG mWT is to promote the use of millimetre wave spectrum from 50 GHz up to 300 GHz for present and future critical transmission applications and use cases. Moreover, ETSIISG mWT will focus on enhancing the confidence of all stakeholders and the general public in the use of millimetre wave technologies." -- ETSI

Learning from the Past

- Pioneering FCC Title III "Permissionless Innovation" actions
  - 1985 unlicensed ISM band (81-413)
  - 1995 60 GHz (92-124)
- Were enabling & "fail-safe"
  - No one harmed if market didn't develop
- Had great benefits 15+ years later
  - Comm. Rosenworcel: $140B economic activity for unlicensed!

mmW & THz Spectrum in US





- Spectrum rather balkanized
- All spectrum >48 GHz shared G/NG
  - ➔ Subject to shared FCC/NTIA jurisdiction
- Allocations stop at 275 GHz
- Passive services well/over(?) represented due to early advocacy but there are also many mobile and fixed allocations
- 95-200 GHz
  - 1/3 passive primary
  - 1/3 passive co-primary

Capital Formation Impacts

- US spectrum-related R&D in general

depends on private capital formation

- While iPhone only needed quick routine approvals, 95+ GHz technology needs *nonroutine* approvals that FCC and NTIA seem to have little interest in at present:
  - Examples of FCC inaction/pending petitions:
    - IEEE-USA §7/95+ GHz petition - Docket 13-259 (7/13)
    - Battelle 105 GHz petition - RM-11713 (2/14)

Capital Formation Impacts

- Do sources of investment capital really want to invest in technologies facing usual R&D and marketing risks PLUS large uncertainty of regulatory delays for market access?
  - Applies to both divisions of large corporations and entrepreneurial firms although worse for entrepreneurs without alternative cash flow while waiting for FCC to act!

FCC Issues

- Minimal interest in §§157,303(g)
  - Even though proactive ISM band and 60 GHz rulemakings with little contemporary support had long term impact
- Large gap between supply and demand for spectrum policy actions
  - Probably dates to 1946: APA & WWII tech
  - Exacerbated by outdated delegations & funding issues (see tinyurl.com/hzj8b4w)
  - UK's Ofcom may delegate better

FCC Issues

- Even Wireless Innovation NOI (09-157) is stagnating despite having been an "OCH pet project"!
- OCH senior staffer has said (privately)
  - "Corporate mergers are always higher priority than new technology items because they add more economic value" - **Really?**
- "Spectrum Frontiers" has become a codeword for more mobile spectrum for cellular carriers in 28-71 GHz and ignores all other "frontiers"

NTIA Issues

- mmW and THz issues fall on classic FCC/NTIA faultline
- All spectrum above 48.2 GHz G/NG shared
- Passive uses, e.g. radio astronomy, has large fraction of ITU allocations (and US reflection thereof) due to WRC preparation ingroup focus on foreseeable needs and IRAC “higher ground” of passive sponsors: NSF, NOAA, and NASA

NTIA Issues

- Passive uses, e.g. radio astronomy, have large fraction of ITU (and US clone thereof) upper allocations due to WRC preparation ingroup focus on foreseeable needs and "higher ground" in IRAC of passive sponsors: NSF, NOAA, and NASA
  - In lower bands passive uses much less dense
  - While NSF is reasonable, NOAA & NASA cling to "wilderness area" spectrum model with no accountability for summary rejection of win/win sharing proposals

Actual IRAC Member Messages on Part 5 License for DARPA Contractor Involving Zero Interference Risk

NASA msg

- "While I would have no difficulty in speaking to you on this subject, the problem is one of policy. It is NASA policy to not allow ANY emissions in ANY bands allocated to exclusive passive use such as given in US246 and RR No. 5.340. For this reason I had no choice but to object to the subject application. In fact, had DARPA applied for the STA through one of the MILDEPS, NASA would have objected to that as well." 12/5/14

DOC (NOAA) msg

- "I understand the use is temporary and that the 95 to 105 GHz band is not the band of eventual interest. Even so, DoC cannot support use of the 100-102 GHz passive band. I have asked my FAS representative to vote accordingly in the FAS." 12/11/14

NTIA Issues

- NTIA staff seems to have little oversight of IRAC deliberations of mmW/THz experimental licenses that intrude in passive spectrum due to
  - Staff seems to forward FAS "black ball" voting of experimental actions to FCC without "smell test"

WRC-19

- At WRC-15 CEPT proposed moving ITU allocations to 450 GHz, APT to 1000 GHz
  - US appears to have had no position
  - CEPT limit adopted with APT wording
  - See http://www.marcus-spectrum.com/Blog/files/WRC19mmWitem1215.html
- USA needs a strategy!
  - There *might* be valid national security reasons to block change
  - If limit is moved passive sharing is key issue
    - Sharing issues very different than at lower bands
    - mmW/THz is not VHF with a few extra zeroes!

Even Indoor Noncommunications Products Face Regulatory Uncertainty

- "Terahertz Spectroscopy" – an indoor short range sensing technology for advanced material analysis
  - https://en.wikipedia.org/wiki/Terahertz_spectroscopy_and_technology
- While sale of equipment is now legal under terms of §302a and §2.803, use would appear to be a §301 violation
- Due diligence issues will arise when investment capital is needed
  - Not unlike Colorado marijuana sector
  - Maybe add to Part 18?

Possible Actions

- FCC & NTIA should press NASA and NOAA leadership that primary status of "spectrum frontier" passive allocations does not exclude sharing with active uses that can be designed to be noninterfering
  - Protect actual and future passive use not a "spectrum wilderness area"
  - Recognize that mmW/THz sharing has different technical options than lower bands

Possible Actions

- NTIA staff should review mmW/THz experimental license actions from IRAC and assure they are based on *actual* interference issues during the experiment term
  - New § 5.85(a)(2) adopted 7/15 provides:
    - "Applications to use any frequency or frequency band exclusively allocated to the passive services (including the radio astronomy service) must include an explicit justification of why nearby bands that have non-passive allocations are not adequate for the experiment. Such applications must also state that the applicant acknowledges that long term or multiple location use of passive bands is not possible and that the applicant intends to transition any long-term use to a band with appropriate allocations."

      (https://apps.fcc.gov/edocs_public/attachmatch/FCC-15-76A1.pdf)

Possible Actions

- It would appear that the provisions of §7(a) apply to <u>both</u> FCC and NTIA and that the burden test apples to issues that NTIA is concerned about
  - "It shall be the policy of the United States to encourage the provision of new technologies and services to the public. Any person or party (other than the Commission) who opposes a new technology or service proposed to be permitted under this chapter shall have the burden to demonstrate that such proposal is inconsistent with the public interest."
- FCC and NTIA should *Chevron* clarify what they think this means

Possible Actions

- Time to start planning for WRC-19 275-450 GHz item
  - If there is a valid national security reason to limit US options better to identify early
  - NASA, NOAA, and NSF should not be able to stonewall against spectrum sharing of passive bands *solely* based on their IRAC seats
    - Should be accountable for consideration of sharing arrangements that protect their legitimate long term interests not their "spectrum portfolio"
  - Most mmW/THz firms are not WRC insiders so some outreach is needed since mainstream firms have little interest in topic

Non-US mmWave & THz R&D

- http://www.etsi.org/deliver/etsi_gs/mWT/001_099/002/01.01.01_60/gs_mWT002v010101p.pdf
  - "With respect to the aforementioned, the mission of ETSI ISG mWT is to promote the use of millimetre wave spectrum from 50 GHz up to 300 GHz for present and future critical transmission applications and use cases. Moreover, ETSIISG mWT will focus on enhancing the confidence of all stakeholders and the general public in the use of millimetre wave technologies."
- https://www.ntt-review.jp/archive/ntttechnical.php?contents=ntr200903sf3.html
- http://phys.org/news/2016-02-terahertz-wireless-technology-fiber-optic-fiber.html
- http://www.fujitsu.com/global/about/resources/news/press-releases/2016/0201-02.html
- http://www.jcnnewswire.com/pressrelease/25015/3/Fujitsu-Develops-World's-First-Compact-300-GHz-Receiver-for-Wireless-Communications-of-Tens-of-Gigab
- http://spectrum.ieee.org/telecom/wireless/a-new-record-for-terahertz-transmission
  - Note exact frequencies used in this German test not revealed. Appears to have used parts of passive band that NASA and NOAA would have objected to in USA - resulting in complex Part 5 deliberations here.

US Entities With mmWave & THz Technology

- Millitech http://www.millitech.com/2014-MMWProducts.htm
- QuinStar Technology http://quinstar.com/amplifier/v-e-w-full-band-medium-power-amplifiers-qam-series/
- Aerowave http://www.aerowave.net/Catalog/24-25.pdf
- MI-WAVE http://miwv.com/drawings/950/MIWV_Series950.pdf
- Virginia Diodes http://vadiodes.com/index.php/en/products/custom-sources-and-receivers
- Norden Millimeter http://www.nordengroup.com/products/amplifiers/75-to-100-ghz/
- SAGE Millimeter http://www.sagemillimeter.com/
- Thorlabs https://www.thorlabs.com/newgrouppage9.cfm?objectgroup_id=8054,
- Lake Shore Cryotronics http://lakeshore.com/products/THz-System/Pages/Overview.aspxtry
- HRL Laboratories http://mmics.hrl.com/
- Luna Innovations/API http://advancedphotonix.com/thzsolutions/